Barneys Canyon Mine
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M/035/009

Kennecott

June 28th, 1994
Mr. Wayne Hedberg
Permit Supervisor - Minerals Regulatory Program
Division of Oil, Gas and Mining
3 Triad Center - Suite 350
Salt Lake City, Utah 84180-1203

Dear Mr. Hedberg:

Enclosed you will find two redlined copies of the updated draft NOI revision submission text and two revised Plate II-Cs. Text that has been added to the document can be clearly recognized because it has been shaded (Redline) and text that was removed has a line through it (Strikeout). You will also find two clean copies of the text which should be used to replace the existing text in the draft submission binders. You will need to retain all of the drawings, figures, appendices and the other plates from the original submission.

Sincerely,

Michael Lee Pagel

Michael Lee Pagel
Chief Engineer
Barneys Canyon Mine

RECEIVED
JUN 29 1994
DIV. OF OIL, GAS & MINING

MINING AND RECLAMATION PLAN

KENNECOTT CORPORATION

BARNEYS CANYON MINE

Melco Expansion Project

SUBMITTED TO UTAH DIVISION OF OIL, GAS AND MINING

March 1, 1994
Revised June 27, 1994

KENNECOTT CORPORATION
BARNEYS CANYON MINE
P. O. BOX 311
Bingham Canyon, Utah 84006-0311

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1.0 INTRODUCTION

Kennecott obtained approval from DOGM in December 1992 to modify its Barneys Canyon mining operations beginning in the first quarter of 1993. The modification involved development and operation of two new open pit mines and expansion of the Melco open pit mine. Process plant facilities, ancillary facilities, and mine service facilities were not affected by the changes. The principal project components were the South BC South, the North BC South, and Melco open pit mines and related mine waste dumps and haulage roads. Pre-stripping of topsoil in the BC South area began in the fourth quarter of 1992 and mining commenced in February of 1993. The finalized version of a combined Notice Of Intent was submitted to DOGM in December 1993.

Kennecott intends to modify its Barneys Canyon mining operations by expanding the size and depth of the North BC South and Melco pits, by creating a series of waste dumps north of the current Melco pit, by redesigning the permitted 7200 dump to improve drainage and by constructing a haul road from the north side of the expanded Melco Pit to the North BC South pit (Plate II-C).

Kennecott requests that its existing permit (reference file number M/035/009) be amended in accordance with the additional operating and reclamation plans presented herein.

1.1 Location

Melco North Dumps	Township 3 South, Range 3 West, Sections 2 and 3 (northern 1/2). Township 2 South, Range 3 West, Sections 34 and 35 (southern 1/8).
Melco 7200 Dump	Township 3 South, Range 3 West, Sections 2 (southern 1/8) and 11 (northwest 1/4).
North Haul Road	Township 3 South, Range 3 West, Section 2 (northern 1/2).

1.2 Land Ownership

1.2.1 Surface Ownership.

1.2.2 Subsurface Ownership.

The Hal LaFleur family no longer has any ownership and should be stricken from Table 1.2.2.

1.2.3 Surface and Mineral Ownership.

1.3 Land Use

1.4 Existing Facilities

1.5 Mineral Exploration

1.6 Utilities and Access

A new haul road will be constructed from the north side of the expanded Melco pit to the North BC South pit. This road will provide shorter ore and waste hauls for the duration of the Melco pit life thereby, reducing fuel consumption and PM_{10} emissions (Plate II-C).

2.0 SITE DESCRIPTION

2.1 Geology

2.1.1 Geologic Setting

2.1.2 Geology of Mineral Deposits

Figure 2.1-12 is a revised geologic cross section showing the pit geology and outline of the Melco mining phases. The line of cross section is shown on the geologic map (Figure 2.1-13).

2.1.3 Subsurface Geology of the Process Facilities Site

2.1.4 Seismicity

2.2 Surface Water Hydrology

The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent and perennial Barneys Creek. The waste dumps will be constructed in accordance with the Utah Division of Water Quality ground water discharge permit.

2.3 Groundwater Hydrology

2.3.1 Regional Aquifer Characteristics

2.3.2 Local Recharge Characteristics

2.3.3 Local Aquifer Characteristics

Extensive additional exploration drilling in and around the Melco pit area indicates that the water level measured in hole MC-31 was a localized anomaly and that the water table is below the 6400 feet AMSL. Additional piezometers installed in the Melco pit area during the later part of 1993 continue to indicate that the ground water table north and south of the pit is around 6400 feet AMSL. A transducer installed approximately under the proposed final pit bottom indicates a ground water table around 6070 feet AMSL.

2.3.4 Baseline Groundwater Quality

2.3.5 Melco and BC South Deposit Area Aquifer Characteristics

The bottom of the expanded Melco pit will be at approximately 6460 feet AMSL. Extensive additional exploration drilling in the area indicates that the water level measured in hole MC-31 was a localized anomaly and that the water table is below 6400 feet AMSL. Additional piezometers installed in the Melco pit area during the later part of 1993 continue to indicate that the ground water table north and south of the pit is around 6400 feet AMSL. A transducer installed approximately under the proposed final pit bottom indicates a ground water table around 6070 feet AMSL. To date, no significant quantities of water have been intercepted in the planned pit area.

2.4 Soils

2.4.1 Technical Approach

A soil survey was conducted by JBR Consultants Group in October-November, 1987 at the Barneys Canyon project site. This survey was supplemented and expanded in October, 1991. The SCS Soil Survey of Salt Lake Area, Utah was used as the basis for the ground survey. Pits or fresh road cuts were used to obtain profile descriptions and define the actual soil boundaries on the project site. Soil samples were obtained and sent to a commercial laboratory for fertility analyses. The average surface layer and subsurface layer thicknesses were used to define potential maximum topsoil depths.

In September 1993, an additional supplemental field soil investigation was conducted by JBR Consultants Group to include soils in the proposed mining expansion area in Barneys Canyon. This investigation consisted of verification and/or refinement, as necessary, of the 1987/91 soils maps and collection of topsoil samples for lab analysis in the area of proposed new developments in Barneys Canyon.

As a result of this supplemental investigation, some minor modifications have been made to the original soils map, resulting in the new Melco Area Soils Map (Plate III-C). The types and quantities of topsoil in the 1993 survey (the Melco expansion area) are detailed in table 2.4-1.

Nutrient and sodium absorption ratio (SAR) analyses were conducted on topsoil samples to determine if any amendments to the topsoil would be needed during reclamation. Topsoil depths were also measured and were determined to be approximately the same as those listed in the previous 1987 - 91 studies.

2.4.2 Soil Types

The soils on the east slope of the Oquirrh Range are derived from mixed sedimentary rocks or the alluvium and colluvium from mixed sedimentary rocks. The soils of the 1993 extended project area all lie above 6,300 feet AMSL and, thus, were not influenced by the prehistoric Lake Bonneville. The soils are calcareous throughout with additional, but variable, lime accumulation in the C horizons. The B horizons are well developed in the deeper soils.

Plate III-C is the modified soil map for the study area. Two main soil associations were surveyed in the Barneys Canyon extended study area. Both the Bradshaw-Agassiz and the Gappmayer-Wallsburg associations are found on the steep south-facing slopes of Barneys canyon. In addition, five main soil series have been identified in the Barneys Canyon study area. In general, within this study area, soil types are closely associated with vegetation types. Agassiz soils are found on the convex portions of the long, steep, south-facing slopes in the study area. Bradshaw soils occur in association with Agassiz soils occupying the concave portions of steep, south-facing slopes. Daybell soils are located on east- and north-facing slopes and are usually defined by the aspen groves they support. Fitzgerald soils are found on the steep north-facing slopes in association with conifer and aspen forests. Gappmayer soils are found on less steep north-facing slopes at lower elevations.

In addition to the five main soil types identified in Barneys Canyon, there are three soil types of minor occurrence. The Wallsburg souls occur with the Gappmayer soils usually occupying ridge tops and the upper parts of steep slopes. Rock outcrops are found throughout the study area on mountain crests and ridges. Deep alluvial soils occur in the drainage bottoms.

The soil chemistry descriptions can be found in Appendix C-III. Detailed descriptions of each soil association are presented below.

Laboratory reports for soil fertility and chemistry are presented in Appendix C-III. In general, the results of the laboratory analyses indicate that the soils available for salvage are of good quality having good nutrient values. Organic matter content is generally high. The soils are generally neutral and have high cation exchange ratios. Phosphorus contents are normal, ranging from 804 to 872 mg/kg. Despite the high chemical quality of the topsoil, much of the topsoil is not suitable for salvaging because of the high quantity of rock fragments, steep slopes, or shallow solum profiles.

Bradshaw-Agassiz Association

Bradshaw

Bradshaw soils occur in association with Agassiz soils occupying the concave portions of steep, south-facing slopes. Taller oak and maple/chokecherry stands indicate the presence of Bradshaw soils. The surface layer is very cobbly silt loam as is the lighter colored subsurface layer. The horizons are weakly developed. The substratum is colluvium developed from limestone and quartzite. According to the SCS the potential for erosion is high. While these soils have relatively poor quality topsoils, the greater depths of the solum, and thus greater volume of soil available, makes stripping desirable. Topsoil depth averages 20 inches but approaches 50 inches in the small drainages and near the bottom of slopes. Stripping would be difficult on the steep slopes but perhaps 70% of the potential topsoil could be recovered, especially if the stripping operation concentrated on the areas of deepest soils. Topsoil quality is rated poor due to excessive amounts of gravels and cobbles in the profile but the soil materials are very fertile as evidenced by increased plant growth in comparison to Agassiz soils.

Agassiz

Agassiz soils are found on the convex portions of the long, steep, south-facing slopes in the study area. The scrubby low-growth of gambel oak indicates that these soils are shallow and low in fertility. The topsoil depth is generally equal to the solum depth, averaging 10 - 12 inches. The quality is poor due to excessive gravel and cobbles in the profile. The SCS describes the potential for erosion as high. Generally it would be unprofitable to strip these soils due to the steepness of the sites and the difficulty of removing the low oak cover. If these soils are to be stripped, the crests of the convex slopes where the soil is shallowest should be avoided.

Daybell

These soils are located on east- and north-facing slopes and are usually defined by the aspen groves they support. However, some Daybell soils also support a mixed stand of conifers and aspen. The Daybell series consists of somewhat excessively drained soils. These soils developed in residuum and colluvium from mixed sedimentary rocks. Slopes range from 40 to 70 percent. The surface layer is dark grayish-brown silt loam and varies greatly from 2 - 29 inches but averages 12 inches. Subsurface layers range from brown to light yellowish-brown very cobbly light sandy loam to a depth of 60 inches or more. The topsoil quality is fair as fertility is good but the soil is excessively gravelly. The topsoil texture is good enough, however, for stripping and should be recovered where feasible. Stripping will only be feasible on the deeper profiles found on the lower portions of the slopes. The removal of aspen and conifer trees will account for about 6 - 9 inches of soil loss, reducing the available topsoil by 30 - 50 percent, depending on the depth of the profile.

Fitzgerald

These soils are found on north-facing slopes where conifer stands are prevalent. The surface layers are dark grayish-brown gravelly loam and the subsurface layers are yellowish-brown gravelly silt loam. The substratum is colluvium and residuum from mixed sedimentary rocks. The SCS lists the potential for erosion as high for this soil type. The average topsoil depth is 18 inches but varies from 10 - 30 inches; the marker of the bottom of the topsoil is the presence of rocks and a yellow-brown sub-soil. The topsoil quality is fair; the presence of excessive gravels lowers the overall quality rating. While soils will be lost when the trees are removed, efforts should be made to recover the remaining soil, especially in the areas of deeper soils.

Gappmayer-Wallsburg Association

Gappmayer

Gappmayer soils are found on the less steep slopes at the lower elevations of the study area. The parent material is colluvium and residuum from mixed sedimentary rocks. The surface layer is very cobbly loam and gravelly silt loam and the subsurface layers are very gravelly silt loam. The SCS states that the potential for erosion is moderate. The mean thickness of this soil unit is 20 inches. It usually supports shrubs and grass but it does extend into the lower elevation conifer stands in some areas. It also forms an ecotone with the Fitzgerald soils. The topsoil quality rating is poor due to the presence of excessive gravels or cobbles. However, the silt loam texture provides a good base for soil fertility. Because this occurs on less rigorous sites it will be easier to strip and recover most of the available topsoil from this unit.

Wallsburg

Wallsburg soils are of minor occurrence in Barneys Canyon. They occur with the Gappmayer soils usually occupying the ridge tops and upper parts of steep slopes. The parent material is colluvium and residuum from mixed sedimentary rocks. The surface layers are very cobbly loam while the subsurface layers are very cobbly silty loam. Bedrock is present at 17 inches. The depth of topsoil is about 15 inches. The potential for erosion is described as high by the SCS. Wallsburg soils are rated unsuitable for topsoil due to the presence of excessive cobblestones throughout the profile. Topsoil from this series should not be considered for stripping.

Rock Outcrops

Rock Outcrops are on ridge-tops and on steep slopes. The crests of the ridges are generally marked by the growth of mountain mahogany shrubs that manage to grow in the rock fractures. These sites have no appreciable soil and should not be considered suitable for stripping.

Alluvial Soil

These soils occur in the drainage bottoms in Barneys Canyon. They are generally deep and very fertile throughout their profile. The range of depths observed during the survey was from 12 to 72 inches. An average depth could not be determined given the small number of observation points and the wide, erratic range of depths observed. Topsoil quality is excellent and these soils should be recovered completely and stockpiled for future reclamation efforts. These soils can be mixed with lesser quality topsoil materials to increase the fertility and volume of the topsoil materials suitable for reclamation.

Table 2.4-1 Summary of Topsoil Materials in the Melco Study Area

Soil	Terrain	Quality	Texture	Mean Depth (inches)	Area (Acres)	Marker*	Salvageable Volume** (CY)
Outcrops	Ridge crests	Unsuitable	Rocky	0	61	None	0
Alluvial	Drainages	Excellent	Silt and clay loams	42	63	Gravel beds	249,018
Agassiz	Steep convex slopes, south aspect	Poor	Gravelly loam	10	120	Bedrock	112,929
Bradshaw	Steep concave slopes, south aspect	Poor	Gravelly/ cobbly silt loam	20	153	Excess gravel	287,986
Daybell	Steep slopes, north aspect	Fair	Gravelly silt loam	12	75	Sandy loam	84,700
Fitzgerald	Steep slopes, north aspect	Fair	Gravelly loam	18	131	Excess stones	221,914
Gappmayer	Moderate slopes, north aspect	Poor	Very gravelly silt loam	20	71	Yellow-brown layer	133,640
Mixed Fitzgerald/ Gappmayer	Moderate to steep slopes, north aspect	Fair to poor	Gravelly loam to very gravelly silt loam	19	40	Excess stones or yellow-brown layer	71,523
Wallsburg	Mountain slopes	Unsuitable	Cobbly silt loam	0	15	None	0
Totals					729		1,161,710

* Marker is the diagnostic field feature for lower limits of topsoil materials
** Volume is based on efficiency of stripping operation which may loose 30% or more on steep slopes or under large plant cover.

2.4.3 Soil Fertility

All the soil materials are very gravelly and/or cobbly so they have large amounts of coarse materials. The soil textures range from loams to silt or clay loams. The organic matter is usually above seven percent which is higher than that normally found in Basin and Range soils. Sufficient plant macronutrients of nitrates, calcium, potassium and magnesium are present for plant growth.

The lab analyses indicate very high iron levels in a few locations. The blending of topsoil materials should ameliorate hot spots.

See Appendix C-III for detailed lab results.

<u>Bradshaw-Agassiz Soils</u>

These cobbly sandy loams are relatively neutral with a high percentage of organic matter in the surface and subsoil horizons. The cation exchange capacity is good. The phosphate levels are good and the other major nutrients are adequate.

<u>Fitzgerald Soil</u>

These cobbly sandy loams are relatively neutral with a high percentage of organic matter in the surface and subsoil horizons. The cation exchange capacity is high. Phosphate levels are good and the other major nutrients are adequate.

<u>Daybell Soils</u>

These sandy loam soils are relatively neutral and moderately fertile with high organic matter (above ten percent) in the surface and subsoil horizons. The cation exchange capacity is very high. Phosphate levels are good and the other major nutrients are adequate.

The other soil groups have been described in previous reports.

2.4.4 Soil Descriptions

The data for the soil descriptions was taken the field surveys, the lab fertility analyses available in Appendix C-III and from the U.S.D.A., S.C.S. <u>Soil Survey of Salt Lake Area, Utah</u>, April 1974.

Series: Agassiz

The Agassiz soil is found in association with Bradshaw soils on the steep south-facing convex portions of slopes.

Family: loamy-skeletal, mixed, frigid Lithic Haploxerolls

Parent Material: residuum and colluvium from mixed sedimentary rock, mainly calcarious quartzite and limestone

Landforms: steep, south-facing slopes, 40 - 70 percent, convex sites

Solum Depth: 12"; range from 6" - 16"

Erosion Hazard: water = high

Range Site: Mountain Shallow Loam

Topsoil Rating: poor
- **depth:** 10"
- **texture:** gravelly or cobbly loam
- **pH:** 6.9, neutral
- **salinity:** none
- **water holding capacity:** 0.10 - 0.12 in/in, low

Typical Pedon:

O1 2 - 0 inches; leaf and twig litter (O1 not always present at every site).

A1 0 - 10 inches; dark grayish brown (10YR 4/2) cobbly or gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; clear wavy boundary.

C1 10 - 16 inches; brown (10YR 5/3) very cobbly silt loam, dark brown (10YR 3/3) moist; very weak, small subangular blocky structure to weak granular structure; slightly hard to loose, very friable, sticky, slightly plastic; common fine roots; abrupt irregular boundary.

R Calcareous quartzite.

Series: Bradshaw

Bradshaw soils occur in association with Agassiz soils on the steep south-facing concave portions of slopes. They are deeper than Agassiz soils and support taller oak and maple/chokecherry woodlands.

Family: loamy-skeletal, mixed, frigid Typic Haploxerolls

Parent Material: colluvium of weathered mixed sedimentary rocks, mainly calcarious quartzite and limestone

Landforms: steep, south-facing slopes, 40 - 70 percent, concave sites

Solum Depth: 50+"

Erosion Hazard: water = high

Range Site: Mountain Stony Loam

Topsoil Rating: poor
depth: 20 inches
texture: very gravelly or cobbly silt loam
pH: 6.9, neutral
salinity: none
water holding capacity: 0.07 - 0.10 in/in, low

Typical Pedon:

O1 2 - 0 inches; leaf and twig litter.

A11 0 - 9 inches; dark brown (7.5YR 4/3) gravelly or cobbly loam, dark brown (7.5YR 3/2) moist; moderate fine granular to small subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common fine and very fine roots and few medium roots; clear, smooth boundary.

A12 9 - 19 inches; dark brown (7.5YR 4/3) gravelly or cobbly clay or silt loam, very dark brown (7.5YR 3/3) moist; moderate, fine granular or small subangular blocky structure; soft, friable, sticky, plastic; common fine and medium roots; gradual, wavy boundary.

B2 19 - 39 inches; dark brown (7.5YR 4/4) very gravelly silt loam, dark brown (7.5YR 3/4) moist; weak, medium and fine subangular blocky to granular structure; soft, friable, slightly sticky and slightly plastic; common fine and few medium roots; gradual, wavy boundary.

C1 39 - 50+ inches; dark brown (7.5YR 5/3) very gravelly silt loam, dark brown (7.5YR 4/3) moist; massive; hard, very firm, slightly sticky, slightly plastic; 80 percent coarse fragments; lime coating on large fragments.

R Weathered limestone.

Series: Daybell

Family: coarse-loamy over fragmental, mixed Pachic Cryoborolls

Parent Material: residuum and colluvium from mixed sedimentary rocks

Landforms: east and north-facing slopes, 40 - 70 percent

Solum Depth: 30"

Erosion Hazard: water = high

Range Site: High Mountain Stony Loam

Topsoil Rating: fair
depth: 12"
texture: very gravelly silt loam
pH: 6.4, neutral
salinity: none
water holding capacity: 0.09 - 0.10 in/in, low

Typical Pedon:

A11 0 - 9 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2 moist; moderate, fine, granular structure; soft, very friable, slightly sticky, non-plastic; common fine roots and few medium roots; 30 percent gravel; slightly acid (pH 6.4); clear, smooth boundary.

A12 9 - 16 inches; brown (10YR 4/3) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine and few medium roots; 30 percent gravel; slightly acid (pH 6.4); clear wavy boundary.

C1 16 - 21 inches; brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 4/3) moist; weak, very fine, granular structure; soft, very friable, nonsticky, non-plastic; common fine roots and few medium roots; 35 percent gravel and cobblestones; slightly acid (pH 6.4); clear wavy boundary.

C2 21 - 52 inches; pale brown (10YR 6/3) very cobbly light sandy loam, yellowish brown (10YR 5/4) moist; weak, very fine, granular structure; slightly hard, very friable, nonsticky, non-plastic; few fine and medium roots; 50 percent cobblestones and gravel; slightly acid (pH 6.4); gradual, irregular boundary.

C3 52 - 60 inches; light yellowish brown (10YR 6/4) very cobbly fine sandy loam, dark yellowish brown (10YR 4/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky, non-plastic; 60 percent cobblestones and gravel; slightly acid (pH 6.4).

R Sandstone.

Series: Fitzgerald

Family: loamy-skeletal, mixed, frigid Mollic Paleboralfs

Parent Material: residuum and colluvium from mixed sedimentary rocks

Landforms: north-facing slopes

Solum Depth: 60+"

Erosion Hazard: water = high

Range Site: none

Topsoil Rating: fair
  depth: 18"
  texture: gravelly loam
  pH: 7.2, neutral
  salinity: none
  water holding capacity: 0.06 - 0.08 in/in, low

Typical Pedon:

O2 0 - 2 inches; very dark grayish brown (10YR 3/2) litter of partially decomposed leaves, grass, and other plant residue, very dark brown (10YR 2/2) moist.

A11 0 - 4 inches; very dark grayish brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, nonsticky, non-plastic; common fine, medium and large roots; neutral (pH 6.8); clear, smooth boundary.

A12 4 - 8 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, slightly sticky, non-plastic; common fine, medium, and large roots; neutral (pH 6.8); abrupt, wavy boundary.

A2 8 - 18 inches; light yellowish brown (10YR 6/4) very gravelly silt loam, yellowish brown (10YR 5/4) moist; moderate, fine granular structure; soft, very friable, slightly sticky, non-plastic; common fine, medium, and large roots; neutral (pH 6.6); gradual, irregular boundary.

B&A 18 - 34 inches; mixed B2t and A2 horizons; B2t part is brown (7.5YR 5/4) very gravelly loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky, non-plastic; few thin clay films; A2 material is like that in the A2 horizon; few fine and large roots; neutral (pH 6.6); clear, wavy boundary.

B2t 34 - 70 inches; reddish yellow (7.5YR 6/6) very gravelly sandy clay loam, yellowish brown (10YR 5/5) moist; moderate, medium, subangular blocky structure; very hard, friable, sticky, plastic; few moderately thick clay films on peds and thin, continuous clay films on coarse fragments; few fine and large roots; neutral (pH 6.6).

Series: Gappmayer

This soil is common at elevations just below Barneys Canyon and occurs only at a few sites in the Barneys Canyon area.

Family: loamy-skeletal, mixed, frigid Boralfic Argixerolls

Parent Material: residuum and colluvium of mixed sedimentary rocks

Landforms: northerly slopes, 30 - 60 percent

Solum Depth: 60+"

Erosion Hazard: water = moderate

Range Site: Mountain Gravelly Loam

Topsoil Rating: poor
- **depth:** 20"
- **texture:** very gravelly silt loam
- **pH:** 6.6 - 7.3, neutral
- **salinity:** none
- **water holding capacity:** 0.08 - 0.10 in/in, low

Typical Pedon:

O1 2 - 0 inches; undecomposed to slightly decomposed litter of oak and conifer leaves and grass.

A1 0 - 10 inches; very dark grayish-brown (10YR 3/2) very cobbly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, nonsticky, non-plastic; many fine and medium roots and few large roots; common fine pores; neutral (pH 6.6); clear, wavy boundary.

A12 10 - 16 inches; grayish brown (10YR 5/2) very gravelly silt loam, dark grayish brown (10YR 3/2) when crushed, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots and few large roots; common fine pores; neutral (pH 6.6); abrupt, wavy boundary.

A2 16 - 20 inches; pale brown (10YR 6/3) very gravelly silt loam, dark brown (10YR 4/3) moist; moderate, fine and medium, granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine pores, neutral (pH 6.6); abrupt wavy boundary.

B21t 20 - 26 inches; pale brown (10YR 6/3) gravelly silty clay loam, grayish brown (10YR 5/2) when crushed, brown (7.5YR 4/4) moist, brown (7.5YR 4/3) moist and crushed; moderate, medium and fine subangular blocky structure; hard, friable, sticky, plastic; common fine roots and few medium and large roots; moderately thick, continuous clay films on most peds and coarse fragments; some peds coated with bleached sand; neutral (pH 6.8); clear, wavy boundary.

B22t 26 - 44 inches; light yellowish brown (10YR 6/4) very gravelly clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium and fine, subangular blocky structure; very hard, friable, sticky, plastic; common fine roots and few medium and large roots; thin, continuous clay films on coarse fragments; neutral (6.8); clear, wavy boundary.

C1 44 - 72 inches; pale brown (10YR 6/3) very gravelly silt loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; common fine roots and few medium roots; below depth of 60 inches this horizon has thin lime coatings on undersides of coarse fragments; matrix noncalcareous; neutral (pH 7.2).

Series: Wallsburg

Family: clayey-skeletal, montmorillonitic, frigid Lithic Argixerolls

Parent Material: residuum and colluvium from sedimentary rocks

Landforms: mountain slopes

Solum Depth: 17"

Erosion Hazard: water = high

Range Site: Mountain Shallow Loam

Topsoil Rating: not suitable
- **depth:** 17"
- **texture:** cobbly silt loam
- **pH:** 6.5 - 7.3, neutral
- **salinity:** none
- **water holding capacity:** 0.05 - 0.10 in/in, low

Typical Pedon:

O1 1 - 0 inches; leaves and twigs.

A1 0 - 5 inches; grayish brown (10YR 5/2) very cobbly silt loam, very dark grayish brown (10YR 3/2) moist; weak, thin platy structure parting to moderate, fine, granular; soft, very friable, slightly sticky and slightly plastic; common fine roots; 50 percent cobblestones and gravel; neutral (pH 6.6); clear, wavy boundary.

B1t 5 - 9 inches; dark brown (10YR 4/3) very cobbly silty clay loam, very dark grayish brown (10YR 3/2) moist, dark brown (7.5YR 3/2) moist and crushed; very hard, friable, sticky, plastic; common fine roots; 60 percent cobblestones; thin continuous clay films; neutral (pH 6.6); clear, wavy boundary.

B2t 9 - 17 inches; brown (7.5YR 5/4) very cobbly light silty clay, dark brown (7.5YR 3/3) moist, brown (7.5YR 4/3) when moist and crushed; strong, medium and fine, angular blocky structure; extremely hard, firm, sticky, plastic; common fine roots; 70 percent cobblestones; thin, continuous clay films; neutral (pH 6.6); clear, irregular boundary.

R 17+ inches; fractured rock.

2.5 Vegetation

The Barneys Canyon area of the Oquirrh Mountains ranges from an elevation of 8,242 feet at Barneys Peak to 6,250 feet at the Melco Haul Road that defines the study boundary. Several plant communities inhabit the steep canyon walls and bottom.

The steep terrain emphasizes the difference in north and south aspects. Douglas fir (Pseudotsuga menziesii), quaking aspen (Populus tremuloides), with intermingled heavy stands of gambel oak (Quercus gambelii) and curl-leaf mountain mahogany (Cercocarpus ledifolius) shrubs characterize north aspects. South aspects mostly support pure gambel oak stands, and on the rocky soils and rock outcrops, curleaf mountain mahogany stands. Steep drainages on the south-facing slopes and the canyon bottom are mostly dominated by the bigtooth maple (Acer grandidentatum)/chokecherry (Prunus virginiana) - riparian community. Sagebrush (Artemisia tridentata) also exists at all south-facing slope elevations associated mostly with the gambel oak community, but only becomes dominant on the higher slopes and ridge tops above the study area.

2.5.1 Methodology

In September 1993 the vegetation of the Barneys Canyon expansion area was mapped and this map is presented as Plate V-C. The area was surveyed on the ground and community boundaries drawn onto topographic maps.

The mapping of communities required the use of aerial photos, U.S.G.S. 7.5 minute maps, and ground-truthing. Ground transects provided a data base of species frequency and dominance for the community descriptions.

The communities were identified by the dominant plant species, which were determined by canopy dominance. For each representative vegetation community, transects were conducted to measure percent cover of dominant species and percent composition of all species encountered.

One hundred-foot, point-intercept transects were conducted in each of the main vegetative communities on the sites of proposed mining activity. Understory as well as canopy species were noted at each foot mark of the transect. The number of transects needed for sample adequacy was determined by using the following formula:

$$n = \frac{t^2 s^2}{(0.2\,x)^2}$$

where n = the desired sample size,

t = the table "t" value at the given confidence level,

s = the standard deviation,

0.2 = the confidence interval around the mean, and

x = the mean

Sample adequacy was achieved at the 80% confidence level.

The vegetative mapping established approximate boundaries for the various communities as described above. In reality these communities do not have definite boundaries but grade from one community to the next. Thus, many community boundaries or extremities are characterized by ecotones. Also many subcommunities or extensions of adjacent communities can exist within the major communities usually due to terrain aberrations.

2.5.2 Survey Results

2.5.2.1 Gambel Oak Community

The Gambel Oak (Quercus gambelii) Community mostly occurs as small shrubs on the higher exposed south-facing ridges, as tall shrubs or small trees on the protected upper slopes, or as medium shrubs at mid-slopes and on the lower alluvial slopes. Occasionally, oak stands occur on north-facing slopes mixed in with the douglas fir (Pseudotsuga menziesii) and aspen (Populus tremuloides) communities.

Within the study area, this plant community ranges in elevation from 6,300 feet near the Melco haul road to 7,600 feet at the extreme northwest corner of the study area. It is characterized by oak woodlands composed of small trees on favorable sites but can be oak shrub stands on less favorable sites. The open areas between shrub and tree stands are vegetated with various grasses and forbs.

The vegetative cover for the Gambel Oak Community is summarized as follows:

Ground Cover, Percent:

Bare soil & Rock	1 - 6, mean 4.8
Litter	15 - 48, mean 25.8
Total Non-vegetative	22 - 49, mean 30.6
Vegetative	51 - 78, mean 69.4
Overstory	6 - 71, mean 41.7

Understory Vegetative Cover:

		Percent
Bromus marginatus	(mountain brome)	0.7
Bromus tectorum	(cheatgrass)	0.7
Elymus glaucus	(blue wildrye)	0.8
Elymus spicatus	(blue-bunch wheatgrass)	11.7
Elymus triticoides	(creeping wildrye)	1.3
Festuca ovina	(sheep fescue)	0.3
Poa secunda	(Sandberg's bluegrass)	3.2
Balsamorhiza sagittata	(balsamroot)	10.3
Lathyrus lanszwertii	(thickleaf sweetpea)	6.0
Mentha arvensis	(field mint)	0.8
Mertensia sp.	(bluebells)	1.3
Penstemon sp.	(Penstemon)	0.5
Senecio sp.	(Senecio)	0.8
Solidago canadensis	(goldenrod)	1.2
Wyethia amplexicaulis	(mulesears)	1.0
unknown forbs		2.5
Acer grandidentatum	(bigtooth maple)	1.0
Chrysothamnus viscidiflorus	(green rabbitbrush)	1.3
Prunus virginiana	(chokecherry)	1.0
Quercus gambelii	(Gambel oak)	16.5
Rosa woodsii	(woods rose)	0.8
Symphoricarpos oreophilus	(mountain snowberry)	4.5

Overstory Vegetative Cover:

Quercus gambelii	(Gambel oak)	12.3
Prunus virginiana	(chokecherry)	0.8

Range Condition: Good

Productivity: 2,400 lbs/acre.

2.5.2.2 Mahogany/Rock Outcrop Community

The Mahogany/Rock Outcrop Community occupies the shallow soils of rocky slopes and mountain crests from about 6,600 feet to 7,960 feet in elevation. Closely associated with this community is the Gambel oak (Quercus gambelii) community. The understory has generally been disturbed by past grazing practices and often consists of mulesears, pepperweed and cheatgrass and scattered sagebrush (Artemisia tridentata). Those mahogany communities in better condition support an understory of bluebunch wheatgrass and a mix of various other perennial grasses and forbs.

The vegetative cover for the Mahogany/Rock Outcrop Community is summarized as follows:

Ground Cover Percent:

Bare Soil & Rock	18 - 25, mean 21.5
Litter	13 - 29, mean 21.0
Total Non-vegetative	31 - 54, mean 37.5
Vegetative	46 - 69, mean 57.5
Overstory	21 - 24, mean 22.5

Understory Vegetative Cover:

		Percent
<u>Bromus</u> <u>marginatus</u>	(mountain brome)	1.5
<u>Bromus</u> <u>tectorum</u>	(cheatgrass)	3.5
<u>Elymus</u> <u>spicatus</u>	(blue-bunch wheatgrass)	1.0
<u>Festuca</u> <u>ovina</u>	(sheep fescue)	4.0
<u>Poa</u> <u>secunda</u>	(Sandberg's bluegrass)	0.5
<u>Allium</u> sp.	(wild onion)	2.0
<u>Lathyrus</u> lanszwertii	(thickleaf sweetpea)	0.5
<u>Lepidium</u> <u>virginicum</u>	(Virginia pepperweed)	1.0
<u>Petradoria</u> <u>pumila</u>	(rock goldenrod)	6.0
<u>Wyethia</u> <u>amplexicaulis</u>	(mulesears)	14.5
<u>Artemisia</u> <u>tridentata</u>	(big sagebrush)	2.0
<u>Cercocarpus</u> <u>ledifolius</u>	(curleaf mountain mahogany)	12.5
<u>Gutierrezia</u> <u>sarothrae</u>	(broom snakeweed)	0.5
<u>Quercus</u> <u>gambelii</u>	(gambel oak)	7.0
<u>Symphoricarpos</u> <u>oreophilus</u>	(mountain snowberry)	1.5

Overstory Vegetative Cover:

<u>Cercocarpus</u> <u>ledifolius</u>	(curleaf mountain mahogany)	22.5

Range condition: good

Productivity: 2,000 lbs/acre

2.5.2.3 Maple/Chokecherry - Riparian Community

The Maple/Chokecherry - Riparian Community varies greatly depending upon the size of the drainage in which it occurs and elevation. Generally, moist side slopes, drainages, and canyon bottom riparian areas have trees and shrubs that grow in dense stands and are taller than the surrounding vegetative community. Where drainages have wide flat channels and floodplains, the deciduous trees can form extensive woodlands. This community varies greatly with respect to composition. Bigtooth maple (Acer grandidentatum) usually dominates on the more mesic northeast-facing hillside sites and in drainage bottoms, and chokecherry (Prunus virginiana) occasionally dominates on slightly dryer northeast-facing hillside sites.

The maple/chokecherry - riparian community in Barneys Canyon is dominated by large stands of maple and/or chokecherry, with scattered gambel oak (Quercus gambelii), douglas fir (Pseudotsuga menziesii) and quaking aspen (Populus tremuloides) intermingling. The understory is comprised of a variety of perennial grasses and forbs.

The vegetative cover for they Maple/Chokecherry - Riparian Community is summarized as follows:

Ground Cover Percent:

Bare Soil & Rock	0 - 3, mean 3.0
Litter	25 - 47, mean 32.7
Total Non-vegetative	25 - 53, mean 35.7
Vegetative	47 - 75, mean 67.3
Overstory	62 - 100, mean 89.3

Understory Vegetative Cover

		Percent
Bromus diandrus	(ripgut brome)	0.3
Bromus marginatus	(mountain brome)	1.3
Carex geyeri	(elk sedge)	2.7
Dactylis glomerata	(orchard grass)	0.3
Elymus spicatus	(blue-bunch wheatgrass)	0.7
Elymus triticoides	(creeping wildrye)	5.3
Achillea millefolium	(yarrow)	0.7
Aster chilensis	(everywhere aster)	1.3
Aster perelegans	(Nuttal aster)	2.3
Lathyrus lanszwertii	(thickleaf sweetpea)	3.0
Mentha arvensis	(field mint)	8.0
Thalictrum fendleri	(Fendler meadowrue)	1.0
Urtica dioica	(stinging nettle)	1.0
Viguiera multiflora	(showy goldeneye)	2.0
Acer grandidentatum	(bigtooth maple)	25.7
Amelanchier alnifolia	(saskatoon serviceberry)	0.3
Prunus virginiana	(chokecherry)	5.0
Pseudotsuga menziesii	(douglas fir)	1.3
Symphoricarpos oreophilus	(mountain snowberry)	2.0

Overstory Vegetative Cover:

Acer grandidentatum	(bigtooth maple)	50.3
Prunus virginiana	(chokecherry)	20.7
Pseudotsuga menziesii	(douglas fir)	1.3
Quercus gambelii	(Gambel oak)	4.0

Range condition: good

Productivity: 2,300 lbs/acre

2.5.2.4 North Slope Douglas Fir Community
The North Slope Douglas Fir Community is mostly confined to the steep north-facing slopes, usually above 6,400 feet in elevation. This community usually consists of large stands of conifer trees with a sparse understory. Snow cover may persist here until early summer keeping the soil moist into the summer season.

In September 1993, field work was conducted to prepare a more detailed map of vegetative communities for the area of proposed expansion. Modifications were made to the map especially with regard to the North Slope Community (Plate V-C).

The vegetative cover for the North Slope Douglas Fir Community is summarized as follows:

Ground Cover Percent:

Bare Soil & Rock	1 - 4, mean 2.3
Litter	38 - 71, mean 58.3
Total Non-vegetative	42 - 74, mean 60.6
Vegetative	26 - 58, mean 56.0
Overstory	72 - 85, mean 81.0

Understory Vegetative Cover		Percent
Bromus marginatus	(mountain brome)	0.3
Thalictrum fendleri	(fendler meadowrue)	0.3
Viola canadensis	(Canada violet)	0.8
Lathyrus lanszwertii	(thickleaf sweetpea)	0.3
Pachystima myrsinites	(mountain lover)	6.0
Physocarpus malvaceus	(mallow ninebark)	3.0
Acer grandidentatum	(bigtooth maple)	4.6
Pseudotsuga menziesii	(douglas fir)	3.0
Symphoricarpos sp.	(snowberry)	3.3
Mahonia repens	(Oregon grape)	14.8
Cercocarpus montanus	(birchleaf mountain mahogany)	1.0
Quercus gambelii	(gambel oak)	3.5

Overstory Vegetative Cover:

Pseudotsuga menziesii	(douglas fir)	70.8
Populus tremuloides	(quaking aspen)	4.5
Prunus virginiana	(chokecherry)	1.8
Physocarpus malvaceus	(mallow ninebark)	2.0
Quercus gambelii	(gambel oak)	1.0
Cercocarpus ledifolius	(curleaf mountain mahogany)	1.0

Range condition: Good

Productivity: 2,000 lbs/acre

2.5.2.5 Quaking Aspen Community
Similar to the Douglas Fir Community, this community is confined to the steep north- and south- facing slopes and drainages of the higher terrain usually above 6,800 feet in elevation, with small colonies existing at lower elevations. The sites occupied by this community are some of the more mesic areas on the Oquirrh Mountains and usually support large trees with a thick brush, grass, and forb understory. As with the douglas fir community, snow cover may persist here until early summer keeping the soil moist.

The quaking aspen community in Barneys Canyon is dominated by large stands of quaking aspen (Populus tremuloides) with a thick understory of bigtooth maple (Acer grandidentatum) and a variety of perennial grasses and forbs.

In September 1993, field work was conducted to prepare a more detailed map of vegetative communities for the area of proposed expansion. Modifications were made to the map especially with regard to the Quaking Aspen Community (Plate V-C).

The vegetative cover for the Quaking Aspen Community is summarized as follows:

Ground Cover Percent:

Bare Soil & Rock	1 - 0, mean 0.7
Litter	23 - 48, mean 32.0
Total Non-vegetative	23 - 49, mean 32.7
Vegetative	51 - 77, mean 67.3
Overstory	79 - 99, mean 89.3

Understory Vegetative Cover		Percent
Bromus inermis	(smooth brome)	1.3
Bromus marginatus	(mountain brome)	1.3
Elymus triticoides	(creeping wildrye)	11.0
Poa reflexa	(nodding bluegrass)	2.7
Asclepias sp.	(milkweed)	0.3
Lathyrus lanszwertii	(thickleaf sweetpea)	3.0
Osmorhiza depauperata	(bluntseed sweetroot)	1.0
Thalictrum fendleri	(fendler meadowrue)	1.0
Verbascum thapsus	(flannel mullein)	0.3
Acer grandidentatum	(bigtooth maple)	25.0
Mahonia repens	(Oregon grape)	0.7
Pachystima myrsinites	(mountain lover)	6.0
Picea pungens	(blue spruce)	0.7
Pseudotsuga menziesii	(douglas fir)	6.3
Sambucus caerulea	(blue elderberry)	0.3
Symphoricarpos sp.	(snowberry)	6.3

Overstory Vegetative Cover:

Acer grandidentatum	(bigtooth maple)	25.3
Populus tremuloides	(quaking aspen)	58.7
Prunus virginiana	(chokecherry)	1.3
Pseudotsuga menziesii	(douglas fir)	2.7
Symphoricarpos sp.	(snowberry)	1.3

Range condition: Good

Productivity: 2,600 lbs/acre

2.6 Wildlife

The project area is located in the mountain brush zone of the Oquirrh Mountains. Included within this broad plant zone are the widespread gambel oak community, the mountain mahogany community on rock outcrop sites, the conifer stands on the steep north slopes, the aspen community at the higher elevations, and the riparian tree community in the major drainages. All of these communities are considered high value wildlife habitats.

The wildlife data was gathered over several survey periods (1987, 1991, 1993) during soil and vegetation surveys. Also, a raptor nest survey was conducted in the fall of 1993. From these sources, a large quantity of qualitative data has been accumulated on the wildlife populations and wildlife habitats of the project areas.

The restricted access and the removal of livestock grazing has allowed wildlife to fully utilize the area with a minimum disturbance and sufficient forage and cover.

2.6.1 Elk

Elk use the area year-round, wintering on the exposed ridges and lower elevations in the gambel oak and mountain mahogany communities. They summer at the highest elevations of the mountain brush zone. Elk numbers are unknown but they are common on the respective use areas. The most critical areas for elk are the calving habitats.

The calving habitats are defined as dense shrub and tree cover with herbaceous and graminoid ground cover sufficient to conceal calves. These habitats are generally confined to northerly aspects in drainages or concave portions of the slopes where mesic conditions provide for optimal plant growth. The plant communities are aspen and conifer or more specifically the ecotone between these communities where several layers of plant growth provide the necessary cover and seclusion.

2.6.2 Mule Deer

Deer also use the project area year-round in a manner similar to Elk. Deer may winter at lower elevations than elk, in the oak and sagebrush communities, because of their inability to negotiate deep snows. Deer are very common in all habitats as the mountain brush zone is the most productive habitat for mule deer in Utah. Deer fawn in areas of heavy ground cover, and in addition to the elk calving habitats described above, would also utilize the heavier oak/maple stands in the concave sites on the slopes and in the riparian zones.

The lack of surface water in much of the project area limits the use of some potential fawning habitats especially during years of below-normal snowfall. Most of the deer summer near the main ridge of the mountains at the higher elevations of the project area due to springs located close to the main ridge.

2.6.3 Predatory Mammals

Coyotes and mountain lions are probably the most common predators in the mountainous habitats. Mountain lions, while very secretive, have been observed in the area. They are attracted to the plentiful large mammal prey supply in a secluded area.

Coyotes are also very common and utilize a wide variety of prey.

The mammalian prey base consists of cottontail rabbits, ground squirrels and tree squirrels, wood rats, mice, voles, and shrews.

2.6.4 Raptors

Large raptors, such as eagles and buteos (large soaring hawks), utilize the large open, mature conifers as roost sites. From observations over the years in the Oquirrh Mountains and recently at Barneys Canyon, large raptors hunt in the valleys and foothills but return in the evening to the high elevations of the mountains to roost. The large open trees and cliffs provide a safe roost site away from disturbance.

The lack of large nests in Barneys Canyon is probably due to the lack of cliff habitats and large open mature conifers. Most of the conifers in the area are second growth or stands on poor sites. These younger or smaller trees lack the open growth type that would be used by large nesting raptors. All of the open mature conifers identified in the survey were searched carefully for nests.

The smaller raptors, more specifically the kestrel falcon and the coopers hawk, are the more common raptors in the mountain brush zone. They prefer this habitat due to the large variety of small bird populations and protective cover of large shrubs and small trees. The multiple layers of plant cover common to the mountain brush zone provide niches for a large variety of birds (which serve as prey for raptors), increasing the density of birds per acre over most other habitats.

The raptor nest survey did not reveal any nests of large raptors. The nests located were of the smaller raptors, especially coopers hawks, that nest in trees in drainages and hunt in the tree and shrub plant communities for small prey. These small nests are not easy to locate and additional small nests may be present in the area due to the abundance of sites in this area. Kestrel falcons nest in tree or rock cavities. None of these raptors are considered endangered species.

Owls, common in the mountain brush zone, include the small screech owl and the flammulated owl, and the larger great-horned owl. Most owls prey on small mammals and medium-sized mammals that inhabit this habitat type; however, the flammulated owl is insectivorous. Owl populations in the project area are unknown due to the lack of surveys specific to detecting owls. Owl nests are rarely observed during raptor nest surveys due to the secretive nesting habitats and nocturnal hunting habitats of owls.

3.0 OPERATION PLAN

Commencing in the 1st quarter of 1994 Kennecott will begin construction of a sulfide flotation plant located next to the existing crushing and conveying infrastructure (Plate II-C). Approximately two million tons of "ore grade" sulfidic material will be liberated as a by product of oxide mining and treated through this flotation plant. Previously these tons would have been treated as waste and blended with oxide waste in the dumps.

The sulfide plant will utilize the existing oxide coarse crushing plant to reduce approximately 8,000 tons per week of sulfide ore to minus 1.5 inch size. Fine crushing and grinding units will produce feed to a flotation plant where approximately 45% of the gold and over 90% of the sulfur (which was originally in the range of 2%-5%) will report to the concentrate. After dewatering, the concentrate (29,000 tons/year) will be shipped offsite for further processing.

The tailings from the flotation plant, containing the remaining 55 percent of the gold, will be partially dewatered and blended with dry oxide ore on the existing agglomerating conveyors for heap leaching.

3.1 Description of Mineral Deposits

3.2 Mining

The Melco pit will be expanded and the bottom of the pit lowered to approximately 6460 feet AMSL to allow extraction of additional ore reserves at depth. A series of new waste dumps will be constructed north of the pit in Barneys Canyon. Annual ore production will be maintained at the 2.6 million tons per year rate while the average annual waste production will increase to approximately 18.5 million tons during 1994 through 1998. The Melco expansion extends the life of the project approximately 3-1/2 years.

The North BC South pit will be expanded and the bottom of the pit lowered to approximately 6460 feet AMSL. The additional waste rock generated by mining the larger pit will be used to cap the existing BCS waste dump and continue backfilling the SBCS pit.

3.2.1 Mining Operations

Waste rock from the Melco pit will be dumped to the north and south of the pit as show in Plate II-C. Construction of a haul road from the north side of the Melco pit to the North BC South pit will shorten the ore and waste hauls. The Melco southern dumps (formerly the 7200 Dump) will be constructed in lifts of up to 1000 feet and will be modified from that already permitted to improve drainage. The Melco north dumps will be constructed in lifts up to 500 feet in height. Other mining operations will remain essentially the same.

3.2.2 Pit Slope Stability Analysis

3.2.3 Carbonaceous Ore Stockpile

The carbonaceous ore stockpile will be rehandled and processed through the sulfide flotation plant.

3.3 Crushing, Screening, Conveying and Stockpiling

Sulfide ore will be batched through the existing crushing plant on a weekly basis and conveyed to a 5,000 ton live capacity enclosed stockpile. The planned annual combined ore tonnage will consist of approximately 417,000 tons of sulfide ore and 2,183,000 tons of oxide ore for a total of 2.6 million tons per year.

Sulfide ore will be reclaimed from the stockpile at a nominal 1,200 tons/day with belt feeders in a reclaim conveyor tunnel. This conveyor will feed a 3 foot Nordberg water flush cone crusher which will discharge into the ball mill sump. Grinding will be accomplished with a ball mill.

The concentrate will be produced in standard mechanical flotation cells, cleaned in a column cell, and reground if necessary. The concentrate will be dewatered in a thickener with a vacuum filter to ensure a proper solids density. The tailings will be metered back to the agglomerating conveyors for blending with the oxide ore stream enroute to the heap leach pads. A generalized site map, flowsheet and building layout are included as Figures 3.3-2, 3.3-3 and 3.3-4. The sulfide plant is located adjacent to the existing crushing facilities (Plate II-C).

3.4 Leaching

3.4.1 Leach Pads

Approximately 10 acres of disturbance will occur from the borrowing of clay for use in the construction of upcoming leach pads. Several potential clay source locations on the property are being evaluated for suitable quality and sufficient quantity. The selected borrow site(s) will be delineated on the map(s) submitted with the 1994 "Annual Report Of Mining Operations".

3.4.2 Solution Conveyances

3.4.3 Solution Ponds

3.5 Leach Solution Processing

3.5.1 Carbon Adsorption

3.5.2 Carbon Stripping

3.5.3 Electrowinning

3.5.4 Carbon Regeneration

3.5.5 Gold Refining

3.6 Ancillary Facilities

Ancillary facilities required for the expansion will be the infrastructure associated with the sulfide flotation plant (Figure 3.3-2).

3.7 Waste Disposal

The expanded mining plan for Melco estimates that a total of 121.4 million tons of waste rock, including all waste mined to date, will be excavated and placed in waste dumps. Of this quantity, approximately 8.2 million tons or 6.8 percent of the waste will be sulfide-bearing or sulfidic waste rock. The sulfide bearing waste generated by the Melco mining operations will be handled in accordance with the existing Utah Division of Water Quality ground water discharge permit.

3.8 Production Schedule

Construction of the Melco north dumps is scheduled to begin in the third quarter of 1994 with prestripping of the Melco D phase planned to begin in early 1995. Mining of the North BC South pit is scheduled to begin in the 4th quarter of 1994.

3.9 Topsoil Management

~~Kennecott will salvage topsoil from areas where salvaging operations can be safely conducted and up to the quantity of topsoil required to achieve the reclamation plan. This topsoil will predominately be salvaged from the main drainage of Barneys Canyon where access is easy and the soil depth the greatest.~~

The rugged terrain and lack of suitable stockpiling locations in the dump areas create a number of operational problems to removal, stockpiling and rehandling. Kennecott reaffirms it's commitment to remove enough topsoil to meet the requirements of the reclamation plan. Only topsoil that meets this requirement and can be safely accessed will be removed. Because of the large quantity of topsoil to be removed, the lack of available stockpiling locations and the staged construction of the waste dumps, staged topsoil removal will be done by direct placement of soil on waste dumps. Proposed topsoil stockpile locations are located on Plate II-C.

3.10 Runoff and Sediment Control

~~The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent and perennial Barneys Creek. Many of the slopes in the watershed area are cross-cut by the KTVX access and exploration roads. These existing roads are intersecting the upslope runoff and channeling the water laterally away from much of the planned dumping area. Where necessary, the existing exploration roads will be upgraded to double as diversionary ditches to keep any runoff water from entering the disturbance areas. The waste dumps will be constructed in stages over the next several years starting in the southern fork of the drainage and progressing downstream to the east. Any runoff water will be handled in accordance with the existing DWQ ground water discharge permit. The operational runoff and sediment control plan can be seen on Plate II-C.~~

The drainage basin above the Melco North dumps is cross cut by 3 roads which existed prior to mine start-up; an old jeep trail to the KTVX facilities, the current access road to the KTVX facilities and a powerline access road which crosses the Oquirrh mountain range. These roads were not constructed by or actively maintained by Barneys Canyon Mine. The current KTVX access road is not under the control of Barneys Canyon Mine and the status of the old jeep road is unknown. The powerline road has been used occasionally for exploration access. As these roads are not owned or maintained by Barneys Canyon Mine, they will continue to remain as permanent structures following the closure of the mine and reclamation. These roads have been labeled on Plate II-C.

Although all three roads have changed the original drainage in the area, the main road of concern is the powerline access road which is located immediately up gradient from the North Dumps. The majority of the basin watershed is intercepted by this road and any runoff water is probably being diverted by this road. The previously submitted draft plan called for upgrading this road to divert runoff water around the waste dumps. This is no longer necessary because of the following changes in the runoff and sediment control plan.

The Melco North dumps will be built in stages to control erosion and sediment, minimize disturbed acres at any one given time, limit the amount of storm runoff water from undisturbed areas, accelerate reclamation by providing areas which can be concurrently reclaimed and minimize the short term impact to Barneys Canyon. The drainage basin has been subdivided into 3 smaller drainage basins which will be referred to as the South basin, North basin and the TV basin (Plate II-C). The generalized plan for dump construction is as follows:

Stage One - South basin - Clear and grub the topsoil removal area for one year's operation, erect brush berms and earthen sediment barriers down gradient of the dump location, remove the safely accessible topsoil from the drainage area and stockpile it up and down gradient from the dump area, tip overburden into the drainage immediately up gradient from the sediment barriers to create a small impoundment for improved sediment control. The dump will be built in an up gradient (towards the west) fashion thereby acting as a permanent sediment control structure. Topsoil removal will proceed to stay ahead of dumping operations. During operations and when the dump is completed, the surface will be sloped towards the west where runoff water will temporarily impound and then infiltrate into the natural ground surface or the coarse rock drain (created by end dumping rock into the canyon) underlying the waste dumps. The storm runoff in the South basin which is not currently being diverted away from the area by the powerline road will be allowed to temporarily impound behind the dump where it will infiltrate into the natural ground.

Stage Two - North basin - Clear and grub the topsoil removal area, erect brush berms and earthen sediment barriers down gradient of the dump location, remove the safely accessible topsoil from the drainage area and stockpile it up and down gradient from the dump area, tip overburden into the drainage immediately up gradient from the sediment barriers to create a small impoundment for improved sediment control. The dump will be built in an up gradient (towards the west) fashion thereby acting as a permanent sediment control structure. Topsoil removal will proceed to stay ahead of operations. During operations and when the dump is completed, the surface will be sloped towards the west where runoff water will temporarily impound and then infiltrate into the natural ground surface or the coarse rock drain created by end dumping. The storm runoff in the North basin which is not currently being diverted away from the area by the powerline road will be allowed to temporarily impound behind the dump where it will infiltrate into the natural ground.

Stage Three - TV basin - Clear and grub the topsoil removal area, erect brush berms and earthen sediment barriers down gradient of the dump location, remove the safely accessible topsoil from the drainage area and stockpile up and down gradient from the dump area, tip overburden into the drainage immediately up gradient from the sediment barriers to create a small impoundment for improved sediment control. Topsoil removal will proceed to stay ahead of operations. During operations and when the dump is completed, the surface will be sloped towards the north where runoff water will temporarily impound and then infiltrate into the natural ground surface or the coarse rock drain created by end dumping. The storm runoff in the TV basin which is not currently being diverted away from the area by the powerline and KTVX access roads will be allowed to temporarily impound behind the dump where it will infiltrate into the natural ground.

The North Access Road will be constructed as an all fill road with waste material from the Melco and NBCS pits. The road surface will drain to the inside of the road where a large ditch has been created between the road fill and the natural ground. This ditch will serve as both a runoff control and sediment control structure. Water will temporarily impound in several sediment basins along the ditch and will infiltrate into the natural ground. Culverts will be installed in the road where required for storm water control.

The only source of runoff water from disturbed areas will be the outslope of the North Access Road and the face of the lower most dump in Barneys Canyon. Control measures will consist of earthen sediment barriers and brush berms constructed under the road slope. These constructions are temporary and will be covered over when the outslope of the North Access Road is dozed down for reclamation. Control measures in the canyon will be monitored for success and if deemed appropriate, a large sediment basin will be constructed up gradient of the where the Melco Haulroad crosses Barneys Canyon.

Historically, major storm events occurring in the canyon cause erosion and carry sediment loads down gradient until the water impounds behind the B&G railroad grade where the sediment drops out and the water infiltrates into the ground. Overall, erosion and sediment control for the whole canyon will be greatly improved by temporarily impounding storm water behind the waste dumps and allowing it to infiltrate into the natural ground. Temporarily impounding the water may also have a beneficial impact on wildlife in the area.

3.10.1 Runoff Volumes Estimates

The Melco north dumps will eventually occupy a large portion of the upper Barneys Canyon main drainage. Approximately 300 acres of the 1430 acre watershed will be disturbed during the mine life. This disturbance will occur at the rate of about 80 acres per year and is not expected to significantly affect the runoff volume estimate due to sediment and runoff control measures..

3.10.2 Operational Runoff Control

The existing runoff control plan has been modified so that runoff water is no longer diverted into the Melco or NBCS pits. Direct precipitation will, of course, continue to fall unimpeded into the pits. The Melco 7200 waste dump has been redesigned to drain away from instead of into the Melco pit. Control measures for the Melco north dumps will use a combination of existing measures (haul road ditches, dump surface sloping, B&G grade and explorations roads).

3.10.3 Operational Sediment Control

The existing operational sediment control plan remains essentially the same with the exception that the Melco and NBCS pits will not be used for long term sediment control. The same sediment control measures will be used for the Melco north dumps as for the south dumps.

3.11 Disturbed Acreage

The additional disturbance acreage for the project expansion is summarized in table 3.11-2.

Table 3.11-2 Expansion Disturbance Area

Location/Site	Disturbance (acres)
Melco Pit Expansion	64.7
Melco North Dumps	221.6
Melco South Dumps	13.5
Melco North Access Road	28.4
North Access Road 2:1Slope	19.9
North BC South Pit Expansion	5.0
Clay Pit Areas	10.0
Total Additional Disturbance	363.1

4.0 IMPACT ASSESSMENT

4.1 Surface Water

~~The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent and perennial Barneys Creek. The waste dumps will be constructed in accordance with DWQ approved water management plans.~~

The long term effect of the Melco North dumps will be to promote the collection and infiltration of storm water into the natural ground surface at a higher elevation in Barneys Canyon. Historically, this creek only flows during significant storm events during which it causes erosion and down gradient migration of sediments. The runoff water becomes impounded behind the B&G railroad grade where it infiltrates into the ground leaving the sediment load behind. The configuration of the waste dumps will provide erosion and sediment controls which nature has not provided. These controls will allow the runoff water to infiltrate into the ground further up gradient prior to causing erosion and becoming laden with sediment. The overall impact to the surface and ground water systems is positive.

4.2 Ground Water

The bottom of the expanded Melco pit will be at approximately 6460 feet AMSL. Extensive additional exploration drilling in the area indicates that the water level measured in hole MC-31 was a localized anomaly and that the water table is below 6400 feet AMSL. To date, no significant quantities of water have been intercepted in the planned pit area.

Additional piezometers installed in the Melco pit area during the later part of 1993 continue to indicate that the ground water table north and south of the pit is around 6400 feet AMSL. A transducer installed approximately under the proposed final pit bottom indicates a ground water table around 6070 feet AMSL. The Melco pit is not expected to impact the ground water system for the following reasons:

1) the majority of the highwall runoff will be collected and diverted out of the pit to the north and south. This is possible because the pit daylights to the north around the 6900 elevation and to the south around the 7000 elevation. The remaining surface area below these elevations is approximately 30 acres and will only receive moisture from meteoric events.

2) eight acres of the lower pit area, consisting of the haulroad and pit bottom, will be ripped, covered with 12 inches of topsoil and reseeded as part of the reclamation plan. Results from HELP modelling indicate very little water will infiltrate past the rooting zone into the underlying water table with the proposed reclamation plan.

3) the deepest part of the proposed pit is 6460 feet AMSL and the water table in that area has now been established to be around 6070 feet AMSL. The small quantity of water available for infiltration (22 surface acres subject to evaporation) is insignificant in comparison to the time required to travel the 400 feet to the water table and the dilution from the thousands of acres of up gradient watershed.

4) the Barneys Canyon Mine Waste Rock Management Plan addresses mitigation measures should the quality of the runoff water become an issue.

4.3 Soil Resources

4.4 Critical Wildlife Habitats

4.5 Air Quality

A revised Approval Order was obtained from the Utah Division of Air Quality on December 20th, 1993 to allow increased dump heights. This new approval order allows the height of the waste dump lifts on the south side of the Melco Mine to increase from 500 feet to 1000 feet and for all other project waste dump heights to increase from 300 feet to 500 feet. On February 9th, 1994 a revised Approval Order was obtained which covers the sulfide flotation plant and associated infrastructure.

4.6 Public Health and Safety

5.0 RECLAMATION PLAN

5.1 Post-mining Land Use

5.2 Demolition and Disposal

5.2.1 Facilities Removal

5.2.2 Demolition Debris Disposal

5.2.3 Hazardous Substances

5.3 Regrading and Process Facilities Closure

Plate IV-C depicts the reclamation treatments for the Melco expansion area and the redesigned Melco south dumps.

5.3.1 Open Pits

5.3.2 Mine Waste Dumps

The configuration of the Melco 7200 dump has been modified to eliminate upgradient watershed runoff water from draining into the pit at mine closure and has resulted in the creation of several internal dumps which disturb approximately 13.5 more acres. These internal dump slopes will be regraded to a slope of 2h:1v and the surface and internal slopes of the dumps covered with approximately one foot of topsoil.

All of the outslopes of the Melco north dumps will to regraded to a slope of 2h:1v and the dump surfaces and slopes covered with approximately one foot of topsoil and revegetated.

5.3.3 Heap Leach Pads and Solution Ponds

5.3.4 Haul Roads

5.4 Soil Materials

5.4.1 Topsoil Application

5.4.2 Topsoil Handling

5.4.3 Topsoil Balance

Soil types for Melco expansion study area are detailed in Table 2.4-1 and on Plate III-C. Much of this soil resides on steep, tree covered slopes and will not be recovered because of safety concerns. The quantity of soil in the area (prior to salvage losses and unsalvaged slopes) is approximately double the amount required for the reclamation plan. Kennecott will salvage topsoil from areas where salvaging operations can be safely conducted and up to the quantity of topsoil required to achieve the reclamation plan. This topsoil will predominately be salvaged from the main drainage of Barneys Canyon where access is easy and the soil depth the greatest.

Table 5.4-3 Expansion Topsoil Application Requirements

Location/Site	Disturbance (acres)	Topsoil (cubic yards)
Melco Pit (pit bottom & road)	7.4	11,939
Melco North Dumps	221.6	357,515
Melco South Dumps	13.5	21,780
Melco North Access Road	28.4	45,819
Melco North Road 2:1 Slope	19.9	32,105
NBCS Pit (pit bottom & road)	1.6	2,581
Clay Pit Areas	10.0	0
Reclamation Requirements	302.4	471,739

Note: Topsoil removed from the clay pit areas will be used for reclamation of the same areas.

5.5 Seedbed Preparation

5.6 Seed Mixture

Table 5.6-1 (Seed Mix for Topsoiled Areas) has been modified to include small burnett (Sanguisorba minor) and forage kochia (Kochia prostrata) at a rate of 1 pound PLS (each) per acre. Mountain big sagebrush (Artemisia tridentata vaseyana) will be used as a substitute for these in the upper pit and dump areas and will be applied at the rate of 1 pound per acre (Table 5.6-1 has not been included in this document).

5.7 Seeding Methods

5.8 Fertilization and Mulching

5.8.1 Fertilization of Topsoiled Areas

5.8.2 Fertilization of Non-Topsoiled Areas

5.8.3 Mulching

5.9 Surface Water Hydrology and Sediment Control

5.9.1 Drainage Plan

Runoff from up gradient watersheds will no longer be routed into the NBCS and Melco pits at mine closure.

5.9.2 Sediment Control Structures

6.0 VARIANCE REQUESTS

6.1 Variance Request from Rule R613-004-111.9 Dams and Impoundments

6.2 Variance Request from Rule R612-004-111.6 Slopes

6.3 Variance Request from Rule R613-004-111.7 Highwalls

6.4 Variance Request from Rule R613-004-111.2 Drainages

6.5 Variance Request from Rule R613-004-111.12 and 111.13 Topsoil Redistribution and Revegetation

7.0 RECLAMATION COST ESTIMATE

The previous cost estimate of $3,604 per acre in 1992 dollars was escalated to 1994 dollars by using the consumer price index of 1.027 for 1992 and 1.03 for 1993 resulting in an updated cost of $3,812 dollars per acre. The previously permitted disturbance area was added to the incremental disturbance area for the Melco and NBCS expansion resulting in a total project disturbance area requiring reclamation as follows:

Currently permitted area requiring reclamation	= 769.5 acres
~~Expansion area requiring reclamation~~	~~= 292.4 acres~~
~~Total project area requiring reclamation~~	~~= 1,061.9 acres~~

~~The total revised reclamation cost is:~~

~~(1,061.9 acres) * ($3,812 per acre) = $4,047,963 (in 1994 dollars)~~

~~This reclamation cost escalates to $4,901,287 in 1999 dollars (multiply by 1.2108) when the reclamation work is assumed to take place. The existing reclamation bond has been increased to that amount.~~

Expansion area requiring reclamation	= 302.4 acres
Total project area requiring reclamation	= 1,071.9 acres

The reclamation cost estimate was adjusted using the Division's current annual escalation factor of 2.10% for 5 years. This results in a multiplier of 1.110 for all 5 years or a reclamation cost of $4,231 per acre in 1999 dollars ($3,812 * 1.110 = $4,231). The existing reclamation bond will be increased to 4.6 million dollars (1,071.9 acres * $4,231 per acre = $4,535,209).

8.0 REFERENCES

JBR Consultants Group, 1988, Notice of Intent to Commence Mining Operations, Kennecott Explorations (Australia) Ltd., Barneys Canyon Project, submitted to Utah Division of Oil Gas and Mining (Revised, September, 1989).

U.S.D.A., Soil Conservation Service, April 1974, Soil Survey of Salt Lake Area, Utah.

APPENDIX C-III

Soil Chemistry Descriptions for Melco North Dump Area